

A User Interface for Semantically Oriented Data Mining of Astronomy Repositories

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Abstract. We present a user-friendly, but powerful interface for the data mining of scientific repositories. We present the tool in use with actual astronomy data and show how it may be used to achieve many different types of powerful semantic queries. The tool itself hides the gory details of query formulation, and data retrieval from the user, and allows the user to create workflows which may be used to transform the data into a convenient form.

1. Motivation and Introduction

Our goal is to create a tool which a scientist may use to author sophisticated queries for data from astronomy repositories and then apply a variety of operations to these data so that the data of interest are acquired. The concept is straightforward. The user indicates the "source" data they want by creating a class with restrictions on its properties. Operations are then applied to convert data into the "goal" form. A directional graph (or workflow) indicates the order and precedence of operations.

For this work, we have focused on application of some semantic technologies. In particular, our tool makes use of an underlying OWL [1] ontology to understand the relationships between astronomical objects and their properties. Using this knowledge our tool may aid the user to prevent creating illegal queries and to aid in the selection of appropriate properties and applicable operations when designing their workflow. The tool also handles the conversion of the source class definition into a SPARQL query [2] and manages the interaction with the astronomical repository (which is a SPARQL endpoint).

2. Viper Graphical User Interface

The Viper GUI (figure 1) is partitioned into 2 main areas, a Chooser, on the left side which is comprised of a number of "palettes" which control how the user may design their workflow and a workspace area, on the right side, where items in the chooser may be dropped to create the science workflow. The workflow shown in figure 1 describes a search for spiral galaxy data from the Hercules supercluster. The spiral galaxy data should have at least one Cepheid star, as well as the properties of W20, Inclination and I-band brightness (apparent magnitude). The last property is also constrained to be brighter than 20th magnitude.

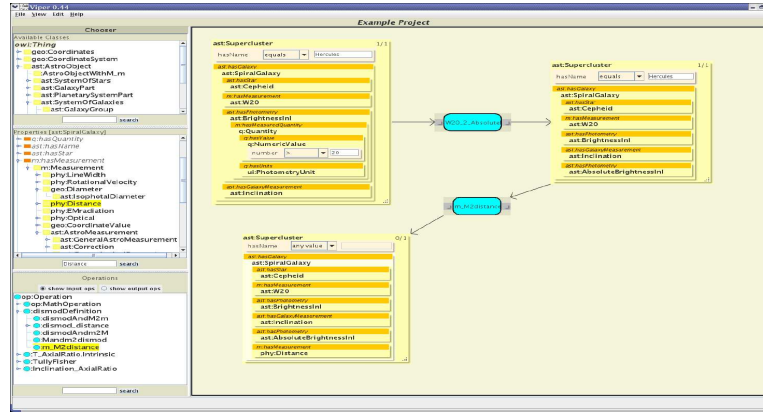


Figure 1. A screen shot of an example project using Viper.

Details of the Chooser and Workspace areas are discussed below. Figure 2 is a guide to the more prominent features of the tool.

2.1. Chooser

The chooser is divided vertically into 3 sections, the "Class Palette", the "Properties Palette" and the "Operations Palette". The Class Palette selection may be dragged and dropped into the workspace to create classes in the workflow. The available properties in the Properties Palette are restricted to whatever class is selected in the Class Palette, hiding illegal properties. Properties from the tree may be dragged over to the selected class to add them¹ and may be further restricted according to their type. The Operations Palette shows legal operations for the selected Class, depending on whether the user wishes to see operations which have the selected class as input or output.

2.2. Workspace

The workflow is a linear chain of alternating classes and operations and starts with the definition of the type of science data to retrieve, the search target and the last class is the "goal". Classes (boxes) from the Chooser are dropped on the workspace. For the selected class in the workspace, properties may then be added. Some properties are object properties, and in this case further recursion is possible where the object of a property may itself have properties (looks like nested boxes in the workspace). Datatype properties may constrain simple data such as strings or numerical values. Operations appear in the workspace as

¹In the search target class only.

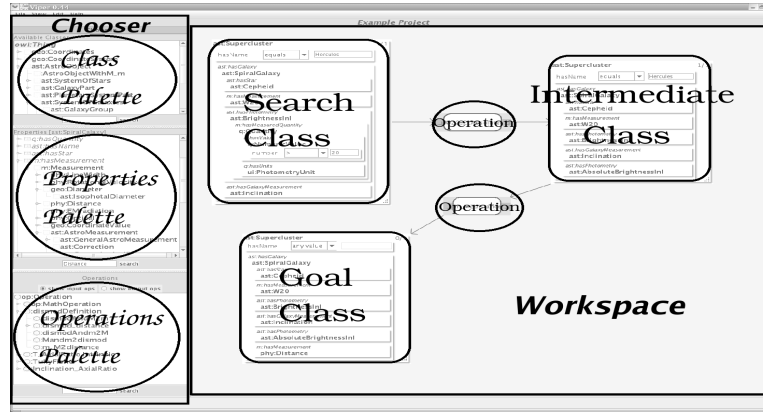


Figure 2. Diagram of significant areas in tool.

linking circles. The characteristics of the operations may be toggled/changed as appropriate (not shown).

The numbers in the north east corner of the classes represent the number of instances which are available at repositories (right hand number), and the number which are "available" (left hand side²). Available instances are viewable, in flattened form, as tables (figure 3) for any selected class in the workflow.

Operations are the only way to change the composition of properties in a class which is not the search target. In figure 1 the middle class in the workflow shows a new property, the I-band absolute magnitude, has been added in a child property class (SpiralGalaxy) after applying a Tully-Fisher transformation.

3. Summary

We have been successful at creating an initial easy to use GUI to manage access to semantic repositories. In order to be applied, the GUI requires that the repository utilize a framework ontology to define measurements and operations [3]. Otherwise, the archivist is free to design any hierarchy of classes they may choose, and software such as D2R [4] makes the mapping of existing tabular databases into a SPARQL endpoint fairly easy.

Nevertheless, there remains significant work to be done on Viper. Presently the tool only manages an interaction with a single repository. We hope that this may be expanded, so as to include multiple repositories, and perhaps interaction to discover repositories via a registry. In terms of improved usability, we hope

²in the search target this means the number downloaded, in other classes it means how many instances are present at that step

DataViewer for : <ast:SpiralGalaxy>						
hasStar	hasGalaxyMeasurement		hasPhotometry		hasMeasurement	
Cepheid	Inclination		BrightnessInI		W20	
	hasMeasur...	hasAccuracy	hasMeasur...	hasAccuracy	hasMeasur...	hasAccuracy
[Object Ref]	Quantity	GaussianE...	Quantity	GaussianE...	Quantity	GaussianE...
	F5.2	F5.2	F5.2	F5.2	F5.2	F5.2
	(---)	(---)	(---)	(---)	(---)	(---)
Cepheid...	6.15	0.12	21.12	1.1	437.44	533.25
Cepheid...	1.97	0.88	22.61	1.4	13.75	574.99

Figure 3. Screen shot of table view of instance data.

to investigate how inference might allow a user to specify the goal class first, and work backwards to various source targets. Furthermore, we expect that by adding special operations to allow the union and intersection of classes will allow for useful non-linear workflows.

References

- [1] OWL, Web Ontology Language, <http://www.w3.org/2004/OWL/>
- [2] SPARQL Query Language for RDF, <http://www.w3.org/TR/rdf-sparql-query/>
- [3] Viper ontology framework and examples, <http://archive.astro.umd.edu/ont/>
- [4] D2R mapping software, <http://sourceforge.net/projects/d2r-map/>